Earth Science Data Systems Software Reuse Working Group
2008 Year-end Report

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2008 Accomplishments

The Software Reuse Working Group (WG) focuses on addressing the issues required to enable and facilitate the reuse of software assets within the NASA Earth science community by undertaking a variety of activities in the areas of implementation, support and enablement, education and public outreach, policy change, and reuse incentives. The main goals of these activities are to help software developers and NASA spend less time, money, and effort on software development, increase productivity and improve quality through reuse, and increase the number of available reusable assets. Activities during 2008 that contributed to these goals included recommendations to NASA Headquarters to encourage and enable software reuse, completion of an architecture study and initial development of a prototype reuse enablement system for internal NASA use, development of test plan and policy documents for the prototype reuse enablement system, continued development and maintenance of a Web-based portal, development of a peer-recognition award process and the first use of the process to issue awards, and continued refinement of reuse readiness levels. These efforts are related to one another, and their success has been due in part to our interactions with other working groups through joint meetings. Throughout the year, we have held monthly full working group telecons and weekly support team telecons.

Recommendations to and Responses from Headquarters: We recommended that NASA develop standard language for use in future procurement and grant notices that will encourage more software reuse, establish a Web-based information portal for the sharing and dissemination of information about software reuse practices for the Earth science community, establish a Reuse Enablement System (RES) to facilitate cataloging and distribution of reusable assets for the Earth science community, and recognize and officially support a Peer-Recognition Software Reuse Award operated by the Reuse WG.

Headquarters has responded positively to our suggestions and is developing language to implement them, e.g., in the ROSES (Earth science) announcements. Headquarters encourages continued development of the Software Reuse Web site (http://www.esdswg.com/softwarereuse). Headquarters is in the process of reviewing the results of our RES Architecture Study, and the policies developed for the RES are now being prepared for presentation to Headquarters.

RES Prototype: Based on the results of our architecture study, we developed a build plan for creating a prototype RES for internal NASA use, using the XOOPS content management system

software as the foundation of the system. The gap analysis performed in the architecture study indicated what modifications were needed in order to meet all of our requirements. These modifications were then ordered and grouped into three builds and one release. We have completed the modifications for Release 1 and are now making minor modifications to improve the user interface and the system's responses to users attempting to perform actions that they do not have permission to perform. We are also preparing a test plan with which to test the prototype RES and ensure that it meets all of the previously defined requirements. This prototype will be presented to Headquarters as a part of a recommendation for building an actual RES.

The WG has also discussed the relation of the proposed RES to the NASA data centers. Recognizing the importance of keeping software with the relevant data, we think that NASA data centers may be a suitable option for hosting one or more reuse enablement systems. In the case of multiple, distributed systems (e.g., one per data center, focused on each center's area of expertise), linkages between them would be necessary to provide easy searching of and access to software in these multiple systems. One central catalog systems could serve this purpose. During initial discussions of this general topic, representatives of some data centers expressed interest in the subject, and we plan to pursue this topic further in the coming year.

RES Policies: As the RES prototype was being developed, early versions of it were presented to the WG for testing, and a demonstration of the prototype was given at the 2007 ESDSWG Meeting. Much of the feedback received about the prototype concerned policy issues, and we recognized that these policy issues must be addressed. We began developing a set of policies for the operation and maintenance of the proposed RES. Relevant requirements were considered during policy development, so that the policies covered how requirements were handled. The basic procedure for policy development was: identify areas where policies are needed, discuss and agree on what the policies should be, draft policies for the identified areas, collect draft policies into a draft policy document, review and edit the draft policy document, check for any gaps or inconsistencies between the policies and requirements, finalize the policy document on a monthly WG telecon, review the policies with the ESDS WG Chair. The policies were categorized into six major areas: user policies, downloads, communications with the community, intellectual property and copyrights, privacy and security of information, and support for users. A section on the definition of user roles was also included, as a needed component for understanding the rest of the policies. We have finalized the current version of the RES Policies document and are currently preparing it for review by the ESDS WG Chair. Additional reviews with other parties may be performed, if deemed appropriate.

Portal Web Site: We designed, developed, and now maintain a Web site (http://www.esdswg.com/softwarereuse) for providing news and information on reusable assets, links to various catalogs (e.g., GCMD, Ames and GSFC Open Source), links to funding opportunities, and dates and contact information for upcoming events relevant to software reuse. Statistics have shown increases in the number of unique, new, and repeat visitors, as well as an increase in the number of visits over the past year. This year, November 2008 had the highest number of unique visitors (1009), but October 2008 was the most popular month in terms of traffic with 1188 visits and 3832 page views from 970 unique visitors, 93% of them being new. Comparing October 2008 with October 2007, the most popular month last year, this year's peak month had approximately twice as many visits and visitors and about one and a half times as

many page views as last year's peak month. The percentage of new visitors is essentially the same, indicating that the site is continually receiving new, first-time visitors.

The WG has a procedure for reviewing nominated selected references for articles to be cited on the portal Web site as external resources relevant to software reuse. At least three independent reviews of each nominated article are required, with the consensus opinion deciding if the article is added to the portal Web site. No articles were reviewed in 2008, but the WG continues to accept nominations for articles and reviews relevant articles as they are nominated.

Other Resources: We also developed and now maintain a collaboration Web site and a WG mailing list. We are also developing a mailing list for announcements related to the RES.
Collaboration Web Site: http://www.sciencedatasystems.org/reuse/default.aspx
Mailing List: http://majordomo.gsfc.nasa.gov/cgi-bin/majordomo/info/software_reuse (Web site is Goddard-only access)
RES List: http://softwarereuse.net/lists/ (prototype – one possible solution for RES list)

Peer-Recognition Award: As part of our work to encourage reuse, we developed a process for a Peer-Recognition Software Reuse Award to be run by the WG as one of our incentive activities. The award is intended to recognize those people whose efforts and projects contribute to the practice of software reuse in the Earth science community. The award consists of a certificate of recognition, an article of recognition featured on the WG portal Web site (http://www.esdswg.com/softwarereuse), announcement of award receipt at the annual ESDSWG Meeting, and acknowledgement of award receipt in the Software Reuse WG annual report. The process was run for the first time in 2008 and resulted in five award recipients:

- Contribution Award Category: 2 recipients
  - **Mercury Consortium**, Oak Ridge National Laboratory
    - *Mercury Distributed Metadata Management, Data Discovery and Access System (http://mercury.ornl.gov/)*

    Recipients (alphabetically): Ranjeet Devarakonda, Jim Green, Chris Lindsley, Giri Palanisamy, Tim Rhyne, Bruce Wilson
  - **UAHuntsville Subset Team**, University of Alabama in Huntsville
    - *HDF-EOS Web-based subsetter (HEW) family of subsetting software (http://subset.org/downloads/software/index.html)*

    Recipients (alphabetically): Bruce Beaumont, Helen Conover, Matthew Smith
- Utilization Award Category: 1 recipient
  - **Data Management Systems and Technologies Group (388J)**, NASA JPL
    - *Object-Oriented Data Technology (OODT) Catalog and Archive Service (CAS) (http://oodt.jpl.nasa.gov/)*

    Recipients (alphabetically): Daniel Crichton, Dana Freeborn, Sean Hardman, John S. Hughes, Sean Kelly, Christian Mattmann, Paul Ramirez, David Woollard
- Peer Education Award Category: 2 recipients
  - **Dr. Victor E. Delnore**, NASA Langley (retired)
    - *Reuse education, in part with NASA ESDS Software Reuse Working Group (http://www.esdswg.com/softwarereuse/)*

- **Dr. Robert R. Downs**, Columbia University
  - *Reuse education, in part with NASA ESDS Software Reuse Working Group (http://www.esdswg.com/softwarereuse/)*

We are also researching the standard processes for instituting new awards at Goddard and NASA to determine if similar reuse awards can be created at those levels, possibly as new categories within existing awards.

Reuse Readiness Levels (RRLs): Leading into the 2007 ESDSWG Meeting, we researched and discussed various topics in software reuse as viewed from the perspective of an individual developer while factoring in what a reuser of the software asset would be interested in knowing. We created a set of levels numbered 1 through 9 for each of nine different topics considered important for measuring reuse readiness. We also began creating a single set of levels that would summarize all of the topic levels. We presented our work on RRLs at the 2007 ESDSWG Meeting and discussed the topic within our own WG to develop a draft set of summary levels, which were then presented to the other WGs for comments and feedback. The RRLs were viewed with much interest, and we received a lot of feedback from the other WGs. Those comments have been addressed through additional iterative revisions of the topic area levels. Additionally, we have developed a prototype RRL calculator to determine an overall reuse readiness level for a software asset based on the assessed maturity level in each of the nine topic areas, by performing an average of the topic areas levels. The user has the option of assigning weights to the topic area levels and calculating a weighted average to determine the overall reuse readiness level. At the 2008 ESDSWG Meeting, we further edited and revised the topic area levels in a group discussion during reuse breakout sessions, and we developed an outline of our next steps in this activity: produce a full document including background, justification, etc., develop use cases for developers and consumers, use the RRLs to assess some existing software assets, use the feedback from the previous steps to revise the RRLs, and have a face-to-face meeting around April 2009 to finalize the levels. The document is currently under development, but much of the work outlined above will continue into next year. When complete, the RRLs will provide individuals with more guidelines on reuse. The RRLs will be presented to Headquarters as a recommendation for measuring the reuse maturity of reusable software assets.

Data Life Cycle: The 2008 ESDSWG Meeting included a plenary session on data life cycle issues and how the WGs might best address them. The Reuse WG covered this topic during one of its breakout sessions as well, and discussed possible areas where we could contribute and assist any potential new group dedicated to addressing data life cycle issues. Reuse Readiness Levels (RRLs) were seen as a possible component of addressing future reuse, most likely in a tailored form, and relating them to the Open Archive Information System model could provide benefits to that model. The proposed Reuse Enablement System (RES) was also deemed important for future reuse. We recognized that policies regarding proprietary and export-controlled software would need to be developed, since those types of software need to be made available in order to permit future reuse, and that an escrow approach to storing them may provide a possible solution. We recognized that it is also important to establish and maintain the relationships between software and data, that some use cases for future reuse could be identified and developed, and that there may be existing data life cycle models that could be reused. We also noted that making data reusable in the future is an issue that should be considered, but that it

may not fall into the scope of our WG. The reuse of software helps with the (re)use of data though, so some of the WG's activities may be applicable to future work on data life cycle issues. We plan to address the issues that are within our scope as we are able to, and intend to work with any new NASA group devoted to addressing data life cycle issues on reuse-related issues.

Decadal Survey Missions: Another new topic covered during the 2008 ESDSWG Meeting was the upcoming missions identified in the Earth Science and Applications from Space decadal survey report. The Reuse WG discussed three topics in relation to how reuse may play a role in the decadal survey missions. First, lessons learned from the Earth Observing System missions were covered, providing some ideas for improvement in the decadal survey missions. Second, the possible role of service oriented architectures and other new technologies such as cloud computing were considered. Third, applicable preparations for the decadal survey missions were identified, including: preserving input data from outside organizations used in algorithms, establishing and maintaining the linkages between data and software, the use of open source software whenever feasible, the use of one or more reuse enablement systems (with links between distributed systems), the need for policies on the use of Web services, and the need for a new community-vetted process for prioritization of algorithms and data sets. We plan to address these relevant issues as we are able to do so.

Publications and Presentations:

- Wolfe, R.E.; Marshall, J.J.; Software Reuse Working Group, "Reuse Readiness Levels (RRLs) – A Work in Progress", presentation at the Winter 2008 ESIP Federation Meeting (January 2008, Washington, D.C.)
- Marshall, J.J.; Downs, R.R.; Samadi, S.; Gerard, N.S.; Wolfe, R.E., "Software Reuse to Support Earth Science," Journal of Frontiers of Computer Science and Technology, 2008, 2(3):296–310. Presented at the Domain Specific Analysis and Design for Reuse workshop at the 10th International Conference on Software Reuse (May 2008, Beijing, China)
- Marshall, J.J.; Downs, R.R., "Reuse Readiness Levels as a Measure of Software Reusability," Geoscience and Remote Sensing Symposium, 2008. IGARSS 2008. IEEE International Conference on, in press. Poster presented at IGARSS 2008 (July 2008, Boston, MA)
- Wolfe, R.E., "NASA Earth Science Data Systems (ESDS) Software Reuse Working Group", presentation at the Summer 2008 ESIP Federation Meeting (July 2008, Durham, NH)
- Leyton, M., "Defining Reuse", presented at the 7th ESDSWG Meeting (October 2008, Philadelphia, PA)
- Marshall, J.J., Berrick, S., Delnore, V. Downs, R.R., Fleig, A., Gerard, N., Gilliam, L., Jasmin, T., Kouvaris, L., Leyton, M., Samadi, S., Sherman, M., Wolfe, R.E., "Policies for a Proposed Reuse Enablement System (RES)" poster presented at the 7th ESDSWG Meeting (October 2008, Philadelphia, PA)
- Marshall, J.J., Downs, R.R., Gilliam, L.J., Wolfe, R.E. (2008), Progress in the Development of a Prototype Reuse Enablement System, *Eos Trans. AGU, 89*(52), Fall Meet. Suppl., Abstract IN11A-1021. Poster presented at the AGU Fall Meeting (December 2008, San Francisco, CA)

2009 Planned Activities

Tasks for Enablement and Policy:

- *Reuse Enablement System:* Develop and implementation plan for deployment, continue developing and testing prototype, deploy the prototype for internal NASA use, develop and vet RES policies (internal and external).
- *Reuse Portal:* Provide more content and keep up-to-date, promote portal to community, add RES roadmap (and schedule for RES deployment eventually).
- *Provide Incentives for Reuse:* Continue with WG peer award, continue to work to develop a NASA reuse award process, work on recommendation/justification for NASA Headquarters to develop a funding opportunity to make assets/components reusable within the Earth science community.
- *Metrics/Measurement:* Continue to generate/analyze statistics for portal Web site, assess efforts required to package assets for reuse, quantify the benefits of open source release of assets, and examine technology transfer process for small vs. large software components, consider using prototype RES to collect metrics, develop impact metrics from peer-award recipients, summarize NPP reuse study for portal Web site.
- *Promote Reuse:* Continue publications in journals and presentations at conferences, prototype a process for facilitating reuse through mentoring, continue developing reuse readiness levels (work with Standards WG and/or Tech. Infusion WG as appropriate).
- *Policy:* Continue working with IPP Office to facilitate software release process, work to understand and change the process (lowering barriers for certain types of software).
- *Data Life Cycle:* work with "new" data life cycle group to help with persistent (re)use areas
- *Decadal Survey Missions:* tie reuse efforts to decadal survey missions, prepare for reuse as a key part of (and asset for) new missions

The goal of all activities for 2009 is to present NASA Headquarters with recommendations for the use of the products developed.

WG Partnerships: Focus on areas of cooperation and collaboration with other WGs, use the Technology Infusion WG capability vision/roadmap as a framework, engage Interoperable Information (Web) Services, help with metadata definition, identify reusable assets for categories of Web services components, HDF product content standards, and identify reusable assets for implementing a possible standard.

Outreach and Education Strategy: We plan to identify outreach and education activities for each audience segment, explore communication opportunities for each activity and audience, prioritize activities to optimize capabilities and interests of team, and develop and identify resources to foster reuse awareness and understanding. Further, we plan to submit articles to Earth science journals, magazines, and bulletins, post Reuse WG announcements on list servers and newsletters, establish community collaboration forums for sharing reuse experiences, and utilize the portal Web site to disseminate outreach and education resources on reuse.

Challenges: We recognize the need to reach out to other Earth Science domains, such as the modeling community (ESMF), the National Forum for Geoscience Information Technology (FGIT), NOAA, EPA, ESIP, etc.

Table 1 – 2008 Contributing Working Group Members

Member Name	Affiliation	NASA-Funded Project	NASA-Funded Project PI
Stephen Berrick	NASA GSFC	Goddard Earth Sciences (GES) Data and Information Services Center (DISC)	
Victor E. Delnore	NASA Langley Research Center	REASoN – Synergistic Data Support of Atmospheric Chemistry Field Campaigns / Chemical Digital Atlas	Victor Delnore
Robert R. Downs	Columbia University Center for International Earth Science Information Network (CIESIN)	Socioeconomic Data and Applications Center (SEDAC)	Robert S. Chen
Yonsook Enloe	SGT Inc. / NASA GSFC	ACCESS – The Development and Delpoyment of a CEOP Satellite Data Server	Kenneth McDonald
Albert Fleig	PITA / NASA GSFC	ACCESS – Atmospheric Composition Processing System (ACPS)	Curt Tilmes
Mike Folk	National Center for Supercomputing Applications (NCSA)	HDF Support for EOSDIS	
Neil Gerard	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Ryan Gerard	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Larry Gilliam	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Tommy Jasmin	University of Wisconsin Space Science and Engineering Center	REASoN – Satellite Observations in Science Education (SOSE)	Steven Ackerman
Virginia Kalb	NASA GSFC		
Louis Kouvaris	SAIC / NASA GSFC	REASoN – A Cross-Calibrated Multi-Platform Ocean Surface Wind Velocity Product for Meteorological and Oceanographic Applications	Joseph Ardizzone
Michael Leyton	Rutgers University		
James J. Marshall	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	

Shahin Samadi	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Mark Sherman	SGT Inc. / NASA GSFC	ACCESS – High Spatial and Temporal Resolution Continental Water Mass Anomaly Fields from GRACE: Improving Accessibility for Hydrological Research and Applications	David Rowlands
Robert E. Wolfe	NASA GSFC	ACCESS – Improving Access to Land and Atmosphere Science Products from Earth Observing Satellites: Helping NACP Investigators Better Utilize MODIS Data Products	Jeffrey Morisette

Table 2 – Additional 2008 Working Group Members

Member Name	Affiliation	NASA-Funded Project	NASA-Funded Project PI
Nadine Alameh	MobiLaps / NASA GSFC	Geosciences Interoperability Office	
Angelo Bertolli	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Howard Burrows	Autonomous Undersea Systems Institute (AUSI) / National Science Digital Library (NSDL)	ESIP Federation	
Bradford Castalia	University of Arizona	High Resolution Imaging Science Experiment (HiRISE)	Alfred McEwen
Saurabh Channan	University of Maryland	Global Land Cover Facility (GLCF)	John Townshend
Stefan Falke	Washington University in St. Louis	REASoN – Services for Helping the Air-quality community use ESE Data (SHAirED)	Stefan Falke and Rudolf Husar
Bill Frakes	Virginia Tech		
Emily Greene	Raytheon / NASA GSFC	Microwave Limb Sounder	
Mary Hunter	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Gary Jackson	University of Maryland	Global Land Cover Facility (GLCF)	John Townshend
Kwo-Sen Kuo	UMBC / NASA GSFC		
Chris Mattmann	NASA JPL	Object-Oriented Data Technology (OODT) Catalog and Archive Service (CAS)	
David McComas	NASA GSFC	Flight Software Systems (GSFC Code 582)	
Stephen Olding	Everware-CBDI / NASA JPL	ESDS Technology Infusion Working Group	
Margaret Pippin	NASA Langley Research Center		
Ross Swick	National Snow and Ice Data Center	Distributed Active Archive Center	
Bill Teng	SSAI / NASA GSFC	REASoN – Integrating NASA ESE Data into Global Agricultural Decision Support Systems	Steven Kempler
Curt Tilmes	NASA GSFC	Atmospheric Composition Processing System (ACPS)	Curt Tilmes

Petr Votava	SGE / NASA Ames		
Frederick Watson	California State University Monterey Bay	REASoN – Systems Integration & Visualization of Yellowstone (SIVY)	Frederick Watson
Christine Whalen	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Jonathan Wilmot	NASA GSFC	Flight Software Systems (GSFC Code 582)	
Bruce Wilson	Oak Ridge National Laboratory	Mercury Distributed Metadata Management, Data Discovery and Access System	